PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-251774
(43)Date of publication of application : 06.09.2002

(51)Int.Cl. G11B 7/135
G02B 5/30
G02F 1/13

(21)Application number : 2001-046432
(22)Date of filing : 22.02.2001

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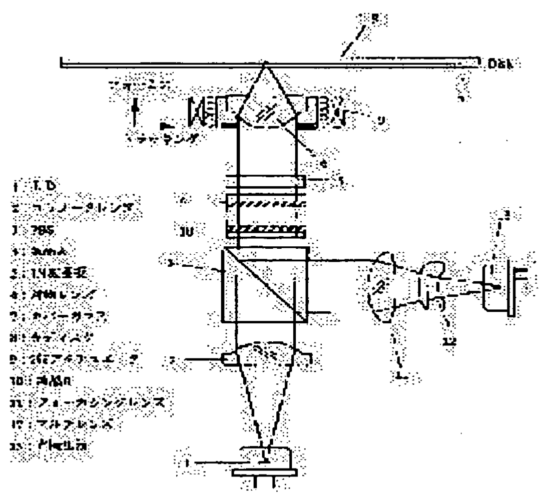
(54) OPTICAL PICKUP AND ITS WAVE FRONT ABERRATION CORRECTING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To appropriately correct wave front aberration caused in an optical system by a liquid crystal element without being affected by a quarter wave plate disposed on an optical path from a light source via a recording medium to a light detector.
SOLUTION: A liquid crystal element A4 is disposed at an advancing light path (a first light path) from the laser light source 1 to an optical disk 8 so as to align a liquid crystal in a polarization direction of light made incident into the optical disk 8 to correct the aberration of advancing light. Separately from the liquid crystal element A4, a liquid crystal element B10 is additionally disposed at returning light path (a second light path) from the quarter plate 5 to the light detector 13 so as to align the liquid crystal in the polarization direction of returning light to correct the aberration of the returning light. Thus, since the polarization states of advancing light and returning light are different from each other by 90 degrees, respective aberrations are independently corrected.



LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]

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CLAIMS

[Claim(s)]
[Claim 1] The optical pickup characterized by what the 2nd liquid crystal device for wave aberration amendment was prepared for in the 2nd optical path to a photodetector from said optical recording medium while preparing the 1st liquid crystal device for wave aberration amendment in the 1st optical path to an optical recording medium from said light source in the optical pickup of the information recorded on said optical recording medium by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector reproduced at least.
[Claim 2] The objective lens for making the information recording surface of said optical recording medium condense the light by which outgoing radiation was carried out from said light source, While being arranged between the phase control component arranged between said light sources and objective lenses, and said light source and phase control component and leading the light from said light source to an optical-recording-medium side It is the optical pickup according to claim 1 characterized by having the optical branching component which leads the reflected light from said optical recording medium to said photodetector, arranging said 1st liquid crystal device between said light sources and objective lenses, and arranging said 2nd liquid crystal device between said phase control components and photodetectors.
[Claim 3] It is the optical pickup according to claim 2 characterized by having arranged said 1st liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said optical recording medium, and having arranged said 2nd liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said photodetector.
[Claim 4] Said the 1st liquid crystal device and 2nd liquid crystal device are an optical pickup according to claim 2 characterized by being arranged between said phase control component and an optical branching component.
[Claim 5] It is the optical pickup according to claim 2 characterized by arranging said 1st liquid crystal device between said phase control component and an optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.
[Claim 6] It is the optical pickup according to claim 2 characterized by arranging said 1st liquid crystal device between said light source and an optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.
[Claim 7] The optical pickup according to claim 1 characterized by consisting of a liquid crystal device with which said the 1st liquid crystal device and 2nd liquid crystal device were united by sharing a middle substrate.
[Claim 8] Said phase control component is an optical pickup according to claim 2 characterized by being a quarter-wave length plate.
[Claim 9] Said optical branching component is an optical pickup according to claim 2 characterized by being a polarization beam splitter.
[Claim 10] Said optical recording medium is an optical pickup according to claim 1 characterized by being a disk mold medium.

[Claim 11] Said light source is an optical pickup according to claim 1 characterized by being the laser light source.
[Claim 12] By carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector In the wave aberration compensator of the optical pickup of the information recorded on said optical recording medium reproduced at least The wave aberration compensator of the optical pickup characterized by having the 1st liquid crystal device for wave aberration amendment arranged at the 1st optical path to an optical recording medium from said light source, and the 2nd liquid crystal device for wave aberration amendment arranged at the 2nd optical path to a photodetector from said optical recording medium.
[Claim 13] An objective lens for said optical pickup to make the information recording surface of said optical recording medium condense the light by which outgoing radiation was carried out from said light source, While being arranged between the phase control component arranged between said light sources and objective lenses, and said light source and phase control component and leading the light from said light source to an optical-recording-medium side It has the optical branching component which leads the reflected light from said optical recording medium to said photodetector. It is the wave aberration compensator of the optical pickup according to claim 12 characterized by arranging said 1st liquid crystal device between said light sources and objective lenses, and arranging said 2nd liquid crystal device between said phase control components and photodetectors.
[Claim 14] It is the wave aberration compensator of the optical pickup according to claim 13 characterized by having arranged said 1st liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said optical recording medium, and having arranged said 2nd liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said photodetector.
[Claim 15] Said the 1st liquid crystal device and 2nd liquid crystal device are the wave aberration compensator of the optical pickup according to claim 13 characterized by being arranged between said phase control component and an optical branching component.
[Claim 16] It is the wave aberration compensator of the optical pickup according to claim 13 characterized by arranging said 1st liquid crystal device between said phase control component and said optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.
[Claim 17] It is the wave aberration compensator of the optical pickup according to claim 13 characterized by arranging said 1st liquid crystal device between said light source and an optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.
[Claim 18] The wave aberration compensator of the optical pickup according to claim 12 characterized by consisting of a liquid crystal device with which said the 1st liquid crystal device and 2nd liquid crystal device were united by sharing a middle substrate.
[Claim 19] Said phase control component is the wave aberration compensator of the optical pickup according to claim 13 characterized by being a quarter-wave length plate.
[Claim 20] Said optical branching component is the wave aberration compensator of the optical pickup according to claim 13 characterized by being a polarization beam splitter.
[Claim 21] Said optical recording medium is the wave aberration compensator of the optical pickup according to claim 12 characterized by being a disk mold medium.
[Claim 22] Said light source is the wave aberration compensator of the optical pickup according to claim 12 characterized by being the laser light source.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical pickup used for various optical recording and/or regenerative apparatus, such as an optical disc system, an optical MAG disc system, and an optical card system, and its wave aberration compensator.
[0002]
[Description of the Prior Art] In recent years, in order to raise the storage capacity of an optical disk in various kinds of record/regenerative apparatus using an optical disk, the semiconductor laser (LD) of short wavelength is used as the light source of an optical pickup, and the lens with a numerical aperture NA high as an objective lens is used. That is, with CD, with 780nm and DVD, like 650nm, the wavelength of the laser used for the light source of an optical pickup is short as recording density becomes high. On the other hand, NA of an objective lens is large as recording density becomes high like [NA / in CD it is called 0.45, and / DVD] 0.60. Moreover, recently, the high NA objective lens 0.85 is used for development of an optical disk with LD of the purple-blue color of 405nm.
[0003] However, if the wavelength of LD becomes short in this way and NA of an objective lens becomes large, wave aberration will increase easily to various manufacture errors, and the problem that optical-character ability deteriorates will arise. Then, more various approaches than before can be considered as an approach of amending this wave aberration, and there is a method of using a liquid crystal device for one of them. This inserts a liquid crystal device between laser and an objective lens, and gives desired phase distribution to the transmitted light. That is, a non-aberration condition is acquired in respect of image formation by giving a phase contrary to wave aberration beforehand to the incident light of an objective lens.
[0004] Hereafter, how to give phase distribution to the transmitted light by the liquid crystal device is explained. First, the glass flat-surface substrate is usually used for two substrates which generally close the liquid crystal molecule of a liquid crystal device, and the electrode is formed in these glass substrates so that an electrical potential difference can be impressed to liquid crystal. And the liquid crystal molecule by which the closure is carried out into these glass substrates is located in a line along with the orientation film formed in each glass substrate, and can carry out the variation rate of the molecular arrangement by impressing an electrical potential difference to the electrode of each glass substrate. And since a refractive index changes in connection with the variation rate of this liquid crystal molecule to the polarization component of a direction which met the orientation film, it is possible to change the phase of the transmitted light. On the other hand, to polarization of the orientation film and the rectangular direction, irrespective of impression of an electrical potential difference, since a refractive index is fixed, a phase change does not happen.
[0005] Next, what is necessary is just to make the distribution of voltage impressed to liquid crystal, in order to give phase distribution to the transmitted light of polarization parallel to such orientation film. As an easy approach for that, an electrode is formed with the electrode divided or more into at least two, and there is a method of applying separately the electrical potential difference according to desired phase distribution to these electrodes. By such approach, the

distribution of voltage corresponding to the number of electrodes and applied voltage is formed, and it becomes possible to give desired phase distribution in approximation to the transmitted light. In this case, such ideal phase distribution can be generated that the number of partitions is fine, of course.
[0006] Moreover, there is the approach of constituting the field configuration of the field which puts the liquid crystal of each glass substrate as other methods of giving the distribution of voltage impressed to liquid crystal, so that the thickness of a liquid crystal molecule may serve as phase distribution and the similarity configuration of aberration. In this case, an electrode is formed in solid one to each substrate side, without dividing. And a uniform electrical potential difference is impressed to an electrode. By this approach, phase distribution of the transmitted light is decided by the thickness of the liquid crystal molecule to penetrate, and the electrical potential difference to impress. And if phase distribution contrary to the wave aberration which optical system in case there is no liquid crystal device in the transmitted light has is given, in respect of image formation, it will become non-aberration.
[0007]
[Problem(s) to be Solved by the Invention] However, in the wave aberration amendment means using the above liquid crystal devices, there are the following troubles generated in the optical path from a record medium to a photodetector. That is, when performing record / playback of a phase change mold disk, or playback of a ROM disk, for example, the polarization condition will lie at right angles by the optical path from laser to a quarter-wave length plate (henceforth lambda/4 plate), and the optical path from lambda/4 plate to a photodetector. Therefore, by the optical path from lambda/4 plate to a photodetector, even if it amends the aberration of the optical system of the optical path from laser to a record medium using a liquid crystal device, since the orientation film and polarization lie at right angles, the aberration of the optical path from a record medium to a photodetector is not amended. If a detection system detects a signal in this condition, when big aberration remains in the optical path from a record medium to a photodetector, the spot on a photodetector expands or deforms, exact detection becomes impossible and the problem that good record/playback cannot be performed arises.
[0008] Then, the purpose of this invention is to offer the optical pickup which can amend the wave aberration produced in optical system proper by the liquid crystal device, and its wave aberration compensator, without being influenced by the light source of the wavelength plate arranged on the optical path which results in a photodetector through a record medium.
[0009]
[Means for Solving the Problem] This invention by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector, in order to attain said purpose While preparing the 1st liquid crystal device for wave aberration amendment in the 1st optical path to an optical recording medium from said light source in the optical pickup of the information recorded on said optical recording medium reproduced at least It is characterized by preparing the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from said optical recording medium. This invention moreover, by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector In the wave aberration compensator of the optical pickup of the information recorded on said optical recording medium reproduced at least It is characterized by having the 1st liquid crystal device for wave aberration amendment arranged at the 1st optical path to an optical recording medium from said light source, and the 2nd liquid crystal device for wave aberration amendment arranged at the 2nd optical path to a photodetector from said optical recording medium.
[0010] In the optical pickup of this invention, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path

from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0011] Moreover, with the wave aberration compensator of this invention, similarly, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0012]

[Embodiment of the Invention] Hereafter, the gestalt of operation of the optical pickup by this invention and its wave aberration compensator is explained. In addition, in the following explanation, although the gestalt of the operation explained below is the suitable example of this invention and desirable various limitation is attached technically, especially the range of this invention shall not be limited to these modes, as long as there is no publication of the purport which limits this invention.

[0013] With the gestalt of this operation, as additional arrangement of the liquid crystal device is carried out and orientation of the liquid crystal is carried out to the optical path (the 2nd optical path) from lambda/4 plate to a photodetector in the polarization direction of return light apart from the liquid crystal device of the optical path (the 1st optical path) from the laser light source in the conventional example mentioned above to a record medium, the aberration of return is amended. Since polarization conditions differ 90 degrees by going and return, aberration is independently amended by such configuration, respectively. As long as the location which arranges this liquid crystal device is the optical path of return, it may be good anywhere, and it may be a location where return has lapped with going.

[0014] Consequently, also in the optical path from a record medium to a photodetector, wave aberration can be amended good. Therefore, it becomes possible to perform record/playback good, without the spot on a photodetector expanding or deforming. In addition, since the aberration generally generated in the 1st optical path from laser to lambda/4 plate and the aberration generated in the 2nd optical path from a record medium to a photodetector are mutually equal, the amount of amendments of the liquid crystal device which amends the aberration of the 1st optical path from laser to lambda/4 plate, and the liquid crystal device which amends the aberration of the 2nd optical path from a record medium to a photodetector is the same, and good. That is, the amount and distribution which orientation only lies at right angles and control the liquid crystal device of two sheets will become the same.

[0015] Hereafter, the concrete example in the gestalt of this operation is explained to a detail using a drawing.

(The 1st example) Drawing 1 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 1st example of this invention. An optical disk 8 is a phase change mold disk or a ROM disk of a metal membrane, cover glass 7 is penetrated, laser light is irradiated by the signal recording surface, and the pit pattern recorded on the signal recording surface is read by the optical pickup. An optical pickup has the biaxial actuator 9 carrying an objective lens 6, by drive control of this biaxial actuator 9, moves an objective lens 6 in the direction of a focus, and the direction of tracking, and performs access to an optical disk 8.

[0016] A collimator lens 2, a polarization beam splitter (optical branching component) 3, liquid

crystal device A4, the liquid crystal device B10, and the quarter-wave length plate (phase control component) 5 are formed in the optical path between the laser light source (LD) 1 and an objective lens 6. Moreover, the focusing glass 11 and the multi-lens 12 are formed in the optical path of a polarization beam splitter 3 and a photodetector 13. Among these, liquid crystal device A4 and a liquid crystal device B10 constitute the wave aberration compensator in this gestalt, liquid crystal device A4 amends the wave aberration of the laser light which carries out incidence to an optical disk 8 from LD1, and a liquid crystal device B10 amends the wave aberration of the return laser light reflected with the optical disk 8. In addition, since it is the same configuration as usual, others are omitted for details.
[0017] Next, the configuration and actuation of a wave aberration compensator in the optical pickup of such this gestalt are explained. Drawing 2 is liquid crystal device A4 used by this example, and the explanatory view showing the structure of B10. Liquid crystal device A4 used by this example and B10 change and arrange the include angle of the liquid crystal device 20 which has common structure mutually, drawing 2 (A) shows the condition at the time of power-source OFF of a liquid crystal device 20, and drawing 2 (B) shows the condition at the time of power-source ON of a liquid crystal device 20. Moreover, drawing 2 (C) shows the forward plane structure of the electrode of a liquid crystal device 20. Like illustration, the liquid crystal device 20 of this example closes the liquid crystal molecule 23 with the glass substrates 21 and 22 of a pair. The electrode layers 24 and 25 for impressing an electrical potential difference to liquid crystal are formed in the opposed face of each glass substrates 21 and 22 according to the power source 26, and the orientation film 27 and 28 is further formed inside each electrode layers 24 and 25. Moreover, as shown in drawing 2 (C), each electrode layers 24 and 25 are divided in the shape of a concentric circle, and acquire the distribution of voltage impressed to liquid crystal by impressing the electrical potential difference of level which is different in each division electrode layer.
[0018] Such a liquid crystal device 20 has the array of the liquid crystal molecule which met the orientation film 27 and 28 at the time of OFF of a power source 26, as shown in drawing 2 (A). And since the liquid crystal molecule which was lying down along the direction of a field of each substrates 21 and 22 will start and a refractive index will change as shown in drawing 2 (B) if a power source 26 is turned on, it is possible to give phase distribution to the transmitted light. In this example, the variation rate of the phase distribution is carried out by the liquid crystal device B10 to the linearly polarized light of the laser light of the return trip (return) which is made to carry out the variation rate of the phase distribution, reflects from an optical disk 8, and carries out incidence to a photodetector 13 by liquid crystal device A4 to the linearly polarized light of the laser light of the outward trip (going) which carries out incidence to an optical disk 8 by using such a liquid crystal device 20 for liquid crystal device A4 and B10.
[0019] In addition, although the distribution of voltage impressed to liquid crystal with a division electrode was acquired in the liquid crystal device 20 shown in drawing 2 , the liquid crystal device 30 constituted so that a substrate configuration might instead be deformed and the thickness of a liquid crystal molecule might serve as phase distribution and the similarity configuration of aberration, as shown in drawing 3 may be used. That is, in the example shown in drawing 3 , the medial surface of one glass substrate 31 of a liquid crystal device 30 has a curvilinear configuration respectively like illustration, and solid formation of the orientation film 37 and the electrode layer 34 is carried out at the medial surface of these glass substrates 31. Moreover, as shown in drawing 3 (C), the electrode layers 34 and 35 of a liquid crystal device 30 are not divided, respectively, but an electrical potential difference common to the whole is impressed according to a power source 36. In addition, the glass substrate 32 and the liquid crystal molecule 33 of another side, and electrode layer 35 grade are as common as the example shown in drawing 2 mentioned above. Also in liquid crystal device A4 using such a liquid crystal device 30, and B10, liquid crystal device A4 mentioned above and the same operation as B10 can be acquired.
[0020] Next, actuation of the wave aberration compensator of the above configurations is explained. First, desired phase distribution is given by 1st liquid crystal device A4 to which the linearly polarized light which faces to an optical disk 8 from the polarization beam splitter prism

(PBS) 3 has the orientation film 27 and 28 in the polarization direction. That is, in liquid crystal device A4, since the liquid crystal molecule which was lying down on the front face of each substrates 21 and 22 will start and a refractive index will change if an electrical potential difference is applied to each electrode layers 24 and 25, it is possible to give phase distribution to the transmitted light. On the other hand, since the 2nd liquid crystal device B10 is making the polarization direction and the orientation film cross at right angles, it does not affect the transmitted light in the optical path from LD1 to an optical disk 8. The light which penetrated liquid crystal device A4 turns into the circular polarization of light with lambda/4 plate 5, and is condensed in respect of the signal of an optical disk 8 with an objective lens 6. Here, the aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.
[0021] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip through lambda/4 plate 5 again. This linearly polarized light can give desired phase distribution by the liquid crystal device B10 which has the orientation film 27 and 28 in that polarization direction. On the other hand, since the polarization direction and the orientation film 27 and 28 are made to cross at right angles in liquid crystal device A4, the transmitted light is not affected in the optical path from lambda/4 plate 5 to a photodetector 13. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. The light which penetrated the liquid crystal device B10 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected from the output of this photodetector 13 toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained. in addition — a liquid crystal device — A4 — a liquid crystal device — B — ten — physical relationship — < — A HREF — = — " — /— Tokujitu/tjitemdrw . — ipdl?N — 0000 — = — 237 — & — N — 0500 — = — one — E_N — /— ; — > —; — = — : — > — 88 —; — /— /— /— & — N — 0001 — = — 815 — & — N — 0552 — = — nine — & — N — 0553 — = — 000003 — " — TARGET — = — "tjitemdrw" — > — drawing 1 — being shown — arrangement — reverse — even if — being the same — effectiveness — obtaining — having .
[0022] (The 2nd example) Drawing 4 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 2nd example of this invention. This 2nd example changes two liquid crystal device A4 mentioned above and arrangement of B10, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. Although arranged between PBS3 and lambda/4 plate 5 like [A4 / 1st / liquid crystal device] the 1st example in this example, the 2nd liquid crystal device B10 is arranged between PBS3 and a focusing glass 11. In addition, also in this example, the configuration of liquid crystal device A4 and B10 the very thing shall be the same as that of the 1st example, for example, what is shown in drawing 2 or drawing 3 shall be used.
[0023] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which faces to an optical disk 8 from PBS3 can give desired phase distribution by liquid crystal device A4 which has the orientation film 27 and 28 in the polarization direction. The light which penetrated liquid crystal device A4 turns into the circular polarization of light with lambda/4 plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8. And the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip (going) through lambda/4 plate 5 again. This linearly polarized light is reflected by PBS3, and desired phase distribution can be given by the liquid crystal device B10 which has the orientation film in that polarization direction. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. As for the light which penetrated the liquid crystal device B10, a focal error signal, a tracking

error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but since the aberration of return light is amended by the liquid crystal device B10 in this example, good detection is attained.

[0024] (The 3rd example) Drawing 5 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 3rd example of this invention. Two liquid crystal device A4 which also mentioned this 3rd example above, and arrangement of B10 are changed, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. This example is arranged between a collimator lens 2 and PBS3, and 1st liquid crystal device A4 arranges the 2nd liquid crystal device B10 between PBS3 and a focusing glass 11 like the 2nd example. In addition, also in this example, the configuration of liquid crystal device A4 and B10 the very thing shall be the same as that of the 1st example, for example, what is shown in drawing 2 or drawing 3 shall be used.

[0025] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which goes to PBS3 from LD1 can give desired phase distribution by liquid crystal device A4 which has the orientation film 27 and 28 in the polarization direction. The light which penetrated liquid crystal device A4 penetrates PBS3, turns into the circular polarization of light with lambda/4 plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of the signal diffraction limitation of an optical disk 8 is obtained. Moreover, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip (going) through lambda/4 plate 5 again. This linearly polarized light is reflected by PBS3, and desired phase distribution can be given by the liquid crystal device B10 which has the orientation film 27 and 28 in that polarization direction. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. And as for the light which penetrated this liquid crystal device B10, a focal signal error, a tracking error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained by it.

[0026] (The 4th example) Drawing 6 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 4th example of this invention. Two liquid crystal device A4 which also mentioned this 4th example above, and arrangement of B10 are changed, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. This example is arranged between a collimator lens 2 and PBS3 like the 3rd example, and 1st liquid crystal device A4 arranges the 2nd liquid crystal device B10 between PBS3 and lambda/4 plate 5 like the 1st example. In addition, also in this example, the configuration of liquid crystal device A4 and B10 the very thing shall be the same as that of the 1st example, for example, what is shown in drawing 2 or drawing 3 shall be used.

[0027] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which goes to PBS3 from LD1 can give desired phase distribution by liquid crystal device A4 which has the orientation film in the polarization direction. And the light which penetrated this liquid crystal device A4 penetrates PBS3, and it carries out incidence to a liquid crystal device B10. Since this liquid crystal device B10 is making the polarization direction and the orientation film cross at right angles, it does not affect the transmitted light. Next, the light which penetrated liquid crystal device A4 turns into the circular polarization of light with lambda/4 plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of such optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0028] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip (going) through lambda/4 plate 5 again. This linearly polarized light can give desired phase distribution by the liquid crystal device B10 which

has the orientation film in that polarization direction. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. And the light which penetrated this liquid crystal device B10 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained.

[0029] (The 5th example) Drawing 7 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 5th example of this invention. This 5th example is an example which has arranged the liquid crystal device 60 which unified these two liquid crystal devices between PBS3 and lambda/4 plate 5 instead of two liquid crystal device A4 mentioned above and B10, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. Drawing 8 is the sectional view showing the structure of a liquid crystal device 60, drawing 8 (A) shows the condition at the time of power-source OFF, and drawing 8 (B) shows the condition at the time of power-source ON. Moreover, drawing 8 (C) shows the forward plane structure of the electrode of a liquid crystal device 60.

[0030] This liquid crystal device 60 unifies two liquid crystal devices 60A and 60B with the plate-like intermediate glass substrate 61, and like the liquid crystal device 30 which showed the glass substrates 62 and 63 of both sides to drawing 3 , it is formed in the shape of [like / in each medial surface / illustration] a curve, and it constitutes them so that the thickness of each liquid crystal molecules 64 and 65 may serve as phase distribution and the similarity configuration of aberration. In liquid crystal device 60A, an electrode layer 70 and the orientation film 72 are formed in the medial surface of the outside glass substrate 62 by solid one, an electrode layer 71 and the orientation film 73 are formed in the medial surface of the intermediate glass substrate 61 at a plane, and the closure of the liquid crystal molecule 64 is carried out between them. The orientation of the liquid crystal molecule 64 of this liquid crystal device 60A is arranged towards return polarization along the substrate side at the time of power-source OFF, as shown in drawing 8 (A).

[0031] On the other hand, in liquid crystal device 60B, an electrode layer 74 and the orientation film 76 are formed in the medial surface of the outside glass substrate 63 by solid one, an electrode layer 75 and the orientation film 77 are formed in the medial surface of the intermediate glass substrate 61 at a plane, and the closure of the liquid crystal molecule 65 is carried out between them. The orientation of the liquid crystal molecule 65 of this liquid crystal device 60B is arranged towards going polarization along the substrate side at the time of power-source OFF, as shown in drawing 8 (A). And in such a liquid crystal device 60, ON of the power sources 66 and 67 of each liquid crystal devices 60A and 60B arranges each liquid crystal molecules 64 and 65 along the transparency direction of light, as shown in drawing 8 (B). In addition, the same effectiveness is acquired even if the physical relationship of liquid crystal device 60A in such a liquid crystal device 60 and liquid crystal device 60B is reverse.

[0032] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which faces to an optical disk 8 from PBS3 penetrates a liquid crystal device 60. As for two liquid crystal devices 60A and 60B which constitute this liquid crystal device 60, the orientation of each liquid crystal molecule can give desired phase distribution by liquid crystal device 60A (liquid crystal device A4) which lies at right angles mutually and has the orientation film in that polarization direction, as for the light of an outward trip (going). Moreover, liquid crystal device 60B (liquid crystal device B10) which has this and the orientation of 90 degrees does not affect phase distribution of light. And the light which penetrated this liquid crystal device 60 turns into the circular polarization of light with lambda/4 plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device 60A, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0033] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which

intersects perpendicularly with an outward trip (going) through lambda/4 plate 5 again. This linearly polarized light can give desired phase distribution by liquid crystal device 60B which has the orientation film in that polarization direction. The aberration of the light which has returned from the signal recording surface of an optical disk 8 by this is amended. Moreover, liquid crystal device 60A which has this and the orientation of 90 degrees does not affect phase distribution of light. The light which penetrated the liquid crystal device 60 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but since the aberration of return light is amended by liquid crystal device 60B in this example, good detection is attained.

[0034] In addition, it is possible to drive two liquid crystal devices A and B which perform aberration amendment of going and return by the objective lens 6 and one in each above example, and this is desirable. That is, when an objective lens 6 drives in the direction of tracking, eccentricity is carried out to the core of liquid crystal, and there is a possibility that aberration may occur. Then, it is possible to really prevent this by drive. Moreover, although each above example explained the example which used the optical recording medium as the optical disk, this invention is applicable similarly about systems, such as not only this but an optical card, and a magneto-optic disk. Moreover, in this invention, what [not only] carries the light source and a photodetector in an optical head block, and moves to one but the thing of the structure which has arranged the light source and a photodetector fixed independently with the optical head block shall be included with an optical pickup.

[0035]

[Effect of the Invention] The 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [as explained above / according to the optical pickup of this invention] an optical recording medium from the light source, while amending the wave aberration of the light which carries out incidence to an optical recording medium, the 2nd liquid crystal device for wave aberration amendment can be prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0036] Moreover, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [according to the wave aberration compensator of this invention] an optical recording medium from the light source, and while amending the wave aberration of the light which carries out incidence to an optical recording medium, the wave aberration of the light which prepares the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from an optical recording medium, reflects from an optical recording medium, and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the optical pickup used for various optical recording and/or regenerative apparatus, such as an optical disc system, an optical MAG disc system, and an optical card system, and its wave aberration compensator.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, in order to raise the storage capacity of an optical disk in various kinds of record/regenerative apparatus using an optical disk, the semiconductor laser (LD) of short wavelength is used as the light source of an optical pickup, and the lens with a numerical aperture NA high as an objective lens is used. That is, with CD, with 780nm and DVD, like 650nm, the wavelength of the laser used for the light source of an optical pickup is short as recording density becomes high. On the other hand, NA of an objective lens is large as recording density becomes high like [NA / in CD it is called 0.45, and / DVD] 0.60. Moreover, recently, the high NA objective lens 0.85 is used for development of an optical disk with LD of the purple-blue color of 405nm.
[0003] However, if the wavelength of LD becomes short in this way and NA of an objective lens becomes large, wave aberration will increase easily to various manufacture errors, and the problem that optical-character ability deteriorates will arise. Then, more various approaches than before can be considered as an approach of amending this wave aberration, and there is a method of using a liquid crystal device for one of them. This inserts a liquid crystal device between laser and an objective lens, and gives desired phase distribution to the transmitted light. That is, a non-aberration condition is acquired in respect of image formation by giving a phase contrary to wave aberration beforehand to the incident light of an objective lens.
[0004] Hereafter, how to give phase distribution to the transmitted light by the liquid crystal device is explained. First, the glass flat-surface substrate is usually used for two substrates which generally close the liquid crystal molecule of a liquid crystal device, and the electrode is formed in these glass substrates so that an electrical potential difference can be impressed to liquid crystal. And the liquid crystal molecule by which the closure is carried out into these glass substrates is located in a line along with the orientation film formed in each glass substrate, and can carry out the variation rate of the molecular arrangement by impressing an electrical potential difference to the electrode of each glass substrate. And since a refractive index changes in connection with the variation rate of this liquid crystal molecule to the polarization component of a direction which met the orientation film, it is possible to change the phase of the transmitted light. On the other hand, to polarization of the orientation film and the rectangular direction, irrespective of impression of an electrical potential difference, since a refractive index is fixed, a phase change does not happen.
[0005] Next, what is necessary is just to make the distribution of voltage impressed to liquid crystal, in order to give phase distribution to the transmitted light of polarization parallel to such orientation film. As an easy approach for that, an electrode is formed with the electrode divided or more into at least two, and there is a method of applying separately the electrical potential difference according to desired phase distribution to these electrodes. By such approach, the distribution of voltage corresponding to the number of electrodes and applied voltage is formed, and it becomes possible to give desired phase distribution in approximation to the transmitted light. In this case, such ideal phase distribution can be generated that the number of partitions is fine, of course.
[0006] Moreover, there is the approach of constituting the field configuration of the field which puts the liquid crystal of each glass substrate as other methods of giving the distribution of

voltage impressed to liquid crystal, so that the thickness of a liquid crystal molecule may serve as phase distribution and the similarity configuration of aberration. In this case, an electrode is formed in solid one to each substrate side, without dividing. And a uniform electrical potential difference is impressed to an electrode. By this approach, phase distribution of the transmitted light is decided by the thickness of the liquid crystal molecule to penetrate, and the electrical potential difference to impress. And if phase distribution contrary to the wave aberration which optical system in case there is no liquid crystal device in the transmitted light has is given, in respect of image formation, it will become non-aberration.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [as explained above / according to the optical pickup of this invention] an optical recording medium from the light source, while amending the wave aberration of the light which carries out incidence to an optical recording medium, the 2nd liquid crystal device for wave aberration amendment can be prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.
[0036] Moreover, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [according to the wave aberration compensator of this invention] an optical recording medium from the light source, and while amending the wave aberration of the light which carries out incidence to an optical recording medium, the wave aberration of the light which prepares the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from an optical recording medium, reflects from an optical recording medium, and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the wave aberration amendment means using the above liquid crystal devices, there are the following troubles generated in the optical path from a record medium to a photodetector. That is, when performing record / playback of a phase change mold disk, or playback of a ROM disk, for example, the polarization condition will lie at right angles by the optical path from laser to a quarter-wave length plate (henceforth lambda/4 plate), and the optical path from lambda/4 plate to a photodetector. Therefore, by the optical path from lambda/4 plate to a photodetector, even if it amends the aberration of the optical system of the optical path from laser to a record medium using a liquid crystal device, since the orientation film and polarization lie at right angles, the aberration of the optical path from a record medium to a photodetector is not amended. If a detection system detects a signal in this condition, when big aberration remains in the optical path from a record medium to a photodetector, the spot on a photodetector expands or deforms, exact detection becomes impossible and the problem that good record/playback cannot be performed arises.
[0008] Then, the purpose of this invention is to offer the optical pickup which can amend the wave aberration produced in optical system proper by the liquid crystal device, and its wave aberration compensator, without being influenced by the light source of the wavelength plate arranged on the optical path which results in a photodetector through a record medium.

[Translation done.]

MEANS

[Means for Solving the Problem] This invention by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector, in order to attain said purpose While preparing the 1st liquid crystal device for wave aberration amendment in the 1st optical path to an optical recording medium from said light source in the optical pickup of the information recorded on said optical recording medium reproduced at least It is characterized by preparing the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from said optical recording medium. Moreover, this invention is characterized by the wave aberration compensator of the optical pickup of the information recorded on said optical recording medium reproduced at least possessing the following by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector. The 1st liquid crystal device for wave aberration amendment arranged at the 1st optical path to an optical recording medium from said light source The 2nd liquid crystal device for wave aberration amendment arranged at the 2nd optical path to a photodetector from said optical recording medium
[0010] In the optical pickup of this invention, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.
[0011] Moreover, with the wave aberration compensator of this invention, similarly, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.
[0012]
[Embodiment of the Invention] Hereafter, the gestalt of operation of the optical pickup by this invention and its wave aberration compensator is explained. In addition, in the following

explanation, although the gestalt of the operation explained below is the suitable example of this invention and desirable various limitation is attached technically, especially the range of this invention shall not be limited to these modes, as long as there is no publication of the purport which limits this invention.

[0013] With the gestalt of this operation, as additional arrangement of the liquid crystal device is carried out and orientation of the liquid crystal is carried out to the optical path (the 2nd optical path) from lambda/4 plate to a photodetector in the polarization direction of return light apart from the liquid crystal device of the optical path (the 1st optical path) from the laser light source in the conventional example mentioned above to a record medium, the aberration of return is amended. Since polarization conditions differ 90 degrees by going and return, aberration is independently amended by such configuration, respectively. As long as the location which arranges this liquid crystal device is the optical path of return, it may be good anywhere, and it may be a location where return has lapped with going.

[0014] Consequently, also in the optical path from a record medium to a photodetector, wave aberration can be amended good. Therefore, it becomes possible to perform record/playback good, without the spot on a photodetector expanding or deforming. In addition, since the aberration generally generated in the 1st optical path from laser to lambda/4 plate and the aberration generated in the 2nd optical path from a record medium to a photodetector are mutually equal, the amount of amendments of the liquid crystal device which amends the aberration of the 1st optical path from laser to lambda/4 plate, and the liquid crystal device which amends the aberration of the 2nd optical path from a record medium to a photodetector is the same, and good. That is, the amount and distribution which orientation only lies at right angles and control the liquid crystal device of two sheets will become the same.

[0015] Hereafter, the concrete example in the gestalt of this operation is explained to a detail using a drawing.

[Translation done.]

EXAMPLE

(The 1st example) Drawing 1 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 1st example of this invention. An optical disk 8 is a phase change mold disk or a ROM disk of a metal membrane, cover glass 7 is penetrated, laser light is irradiated by the signal recording surface, and the pit pattern recorded on the signal recording surface is read by the optical pickup. An optical pickup has the biaxial actuator 9 carrying an objective lens 6, by drive control of this biaxial actuator 9, moves an objective lens 6 in the direction of a focus, and the direction of tracking, and performs access to an optical disk 8.

[0016] A collimator lens 2, a polarization beam splitter (optical branching component) 3, liquid crystal device A4, the liquid crystal device B10, and the quarter-wave length plate (phase control component) 5 are formed in the optical path between the laser light source (LD) 1 and an objective lens 6. Moreover, the focusing glass 11 and the multi-lens 12 are formed in the optical path of a polarization beam splitter 3 and a photodetector 13. Among these, liquid crystal device A4 and a liquid crystal device B10 constitute the wave aberration compensator in this gestalt, liquid crystal device A4 amends the wave aberration of the laser light which carries out incidence to an optical disk 8 from LD1, and a liquid crystal device B10 amends the wave aberration of the return laser light reflected with the optical disk 8. In addition, since it is the same configuration as usual, others are omitted for details.

[0017] Next, the configuration and actuation of a wave aberration compensator in the optical pickup of such this gestalt are explained. Drawing 2 is liquid crystal device A4 used by this example, and the explanatory view showing the structure of B10. Liquid crystal device A4 used by this example and B10 change and arrange the include angle of the liquid crystal device 20 which has common structure mutually, drawing 2 (A) shows the condition at the time of power-source OFF of a liquid crystal device 20, and drawing 2 (B) shows the condition at the time of power-source ON of a liquid crystal device 20. Moreover, drawing 2 (C) shows the forward plane structure of the electrode of a liquid crystal device 20. Like illustration, the liquid crystal device 20 of this example closes the liquid crystal molecule 23 with the glass substrates 21 and 22 of a pair. The electrode layers 24 and 25 for impressing an electrical potential difference to liquid crystal are formed in the opposed face of each glass substrates 21 and 22 according to the power source 26, and the orientation film 27 and 28 is further formed inside each electrode layers 24 and 25. Moreover, as shown in drawing 2 (C), each electrode layers 24 and 25 are divided in the shape of a concentric circle, and acquire the distribution of voltage impressed to liquid crystal by impressing the electrical potential difference of level which is different in each division electrode layer.

[0018] Such a liquid crystal device 20 has the array of the liquid crystal molecule which met the orientation film 27 and 28 at the time of OFF of a power source 26, as shown in drawing 2 (A). And since the liquid crystal molecule which was lying down along the direction of a field of each substrates 21 and 22 will start and a refractive index will change as shown in drawing 2 (B) if a power source 26 is turned on, it is possible to give phase distribution to the transmitted light. In this example, the variation rate of the phase distribution is carried out by the liquid crystal device B10 to the linearly polarized light of the laser light of the return trip (return) which is

made to carry out the variation rate of the phase distribution, reflects from an optical disk 8, and carries out incidence to a photodetector 13 by liquid crystal device A4 to the linearly polarized light of the laser light of the outward trip (going) which carries out incidence to an optical disk 8 by using such a liquid crystal device 20 for liquid crystal device A4 and B10.

[0019] In addition, although the distribution of voltage impressed to liquid crystal with a division electrode was acquired in the liquid crystal device 20 shown in drawing 2 , the liquid crystal device 30 constituted so that a substrate configuration might instead be deformed and the thickness of a liquid crystal molecule might serve as phase distribution and the similarity configuration of aberration, as shown in drawing 3 may be used. That is, in the example shown in drawing 3 , the medial surface of one glass substrate 31 of a liquid crystal device 30 has a curvilinear configuration respectively like illustration, and solid formation of the orientation film 37 and the electrode layer 34 is carried out at the medial surface of these glass substrates 31. Moreover, as shown in drawing 3 (C), the electrode layers 34 and 35 of a liquid crystal device 30 are not divided, respectively, but an electrical potential difference common to the whole is impressed according to a power source 36. In addition, the glass substrate 32 and the liquid crystal molecule 33 of another side, and electrode layer 35 grade are as common as the example shown in drawing 2 mentioned above. Also in liquid crystal device A4 using such a liquid crystal device 30, and B10, liquid crystal device A4 mentioned above and the same operation as B10 can be acquired.

[0020] Next, actuation of the wave aberration compensator of the above configurations is explained. First, desired phase distribution is given by 1st liquid crystal device A4 to which the linearly polarized light which faces to an optical disk 8 from the polarization beam splitter prism (PBS) 3 has the orientation film 27 and 28 in the polarization direction. That is, in liquid crystal device A4, since the liquid crystal molecule which was lying down on the front face of each substrates 21 and 22 will start and a refractive index will change if an electrical potential difference is applied to each electrode layers 24 and 25, it is possible to give phase distribution to the transmitted light. On the other hand, since the 2nd liquid crystal device B10 is making the polarization direction and the orientation film cross at right angles, it does not affect the transmitted light in the optical path from LD1 to an optical disk 8. The light which penetrated liquid crystal device A4 turns into the circular polarization of light with lambda/4 plate 5, and is condensed in respect of the signal of an optical disk 8 with an objective lens 6. Here, the aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0021] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip through lambda/4 plate 5 again. This linearly polarized light can give desired phase distribution by the liquid crystal device B10 which has the orientation film 27 and 28 in that polarization direction. On the other hand, since the polarization direction and the orientation film 27 and 28 are made to cross at right angles in liquid crystal device A4, the transmitted light is not affected in the optical path from lambda/4 plate 5 to a photodetector 13. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. The light which penetrated the liquid crystal device B10 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected from the output of this photodetector 13 toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained. In addition, the same effectiveness is acquired even if the physical relationship of liquid crystal device A4 and a liquid crystal device B10 is contrary to the arrangement shown in drawing 1 .

[Translation done.]

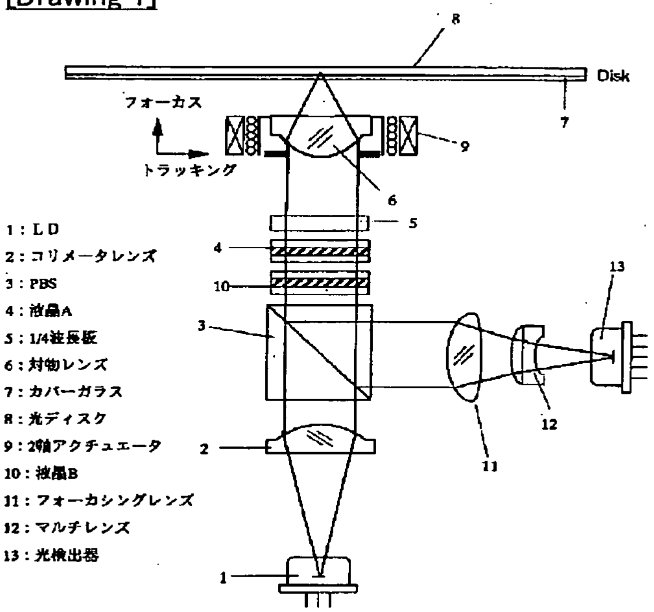
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup in the 1st example of this invention.
[Drawing 2] It is the explanatory view showing the 1st example of a liquid crystal device prepared in the optical pickup shown in drawing 1 .
[Drawing 3] It is the explanatory view showing the 2nd example of a liquid crystal device prepared in the optical pickup shown in drawing 1 .
[Drawing 4] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 2nd example of this invention.
[Drawing 5] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 3rd example of this invention.
[Drawing 6] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 4th example of this invention.
[Drawing 7] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 5th example of this invention.
[Drawing 8] It is the explanatory view showing the example of a liquid crystal device prepared in the optical pickup shown in drawing 7 .
[Description of Notations]
1 [.. A liquid crystal device A, 5 / .. A quarter-wave length plate, 6 / .. An objective lens, 7 / .. Cover glass, 8 / .. An optical disk, 9 / .. A biaxial actuator, 10 / .. A liquid crystal device B, 11 / .. A focusing glass, 12 / .. A multi-lens, 13 / .. Photodetector.] .... The laser light source (LD), 2 .. A collimator lens, 3 .. A polarization beam splitter (PBS), 4

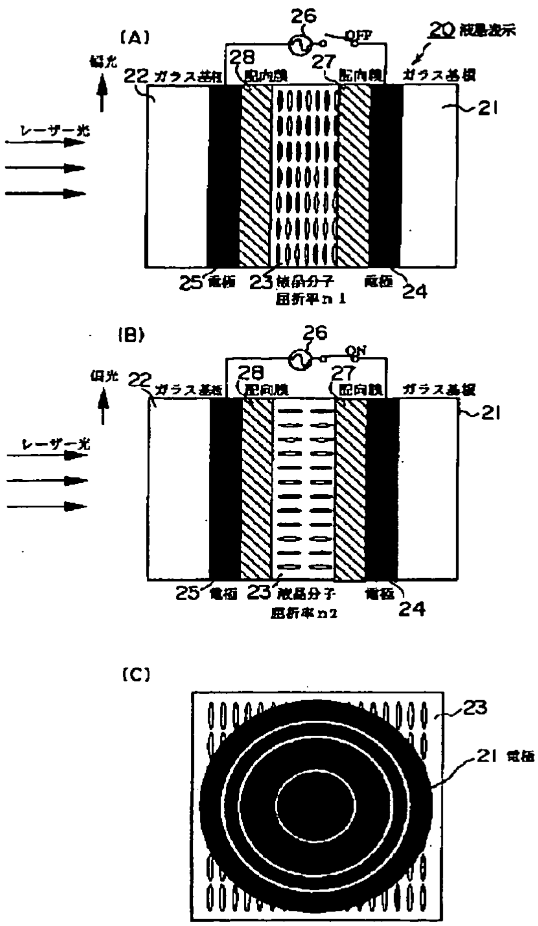
[Translation done.]

DRAWINGS

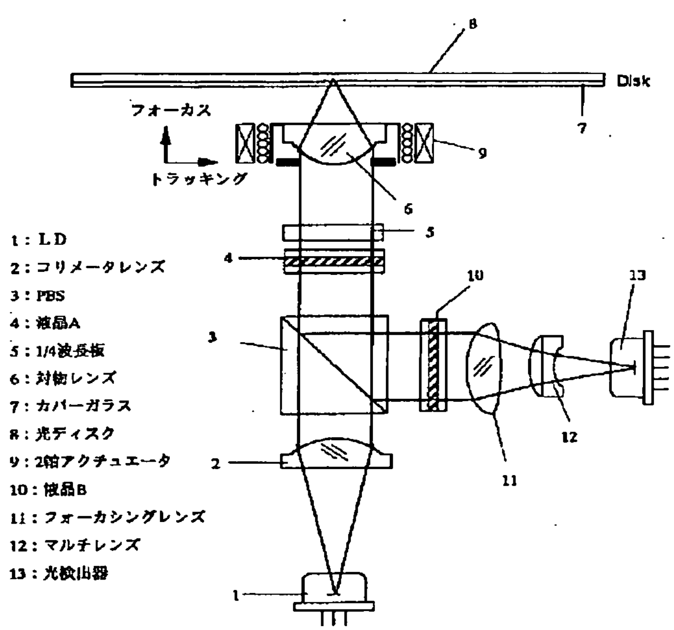
[Drawing 1]



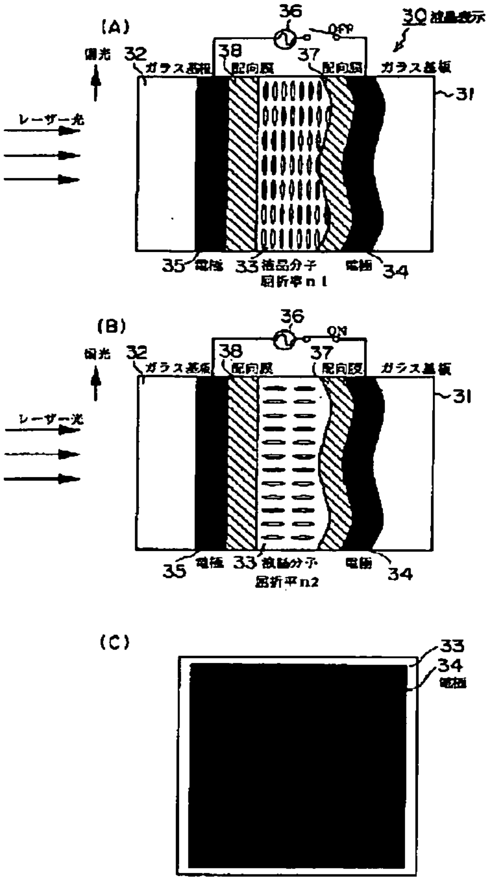
[Drawing 2]



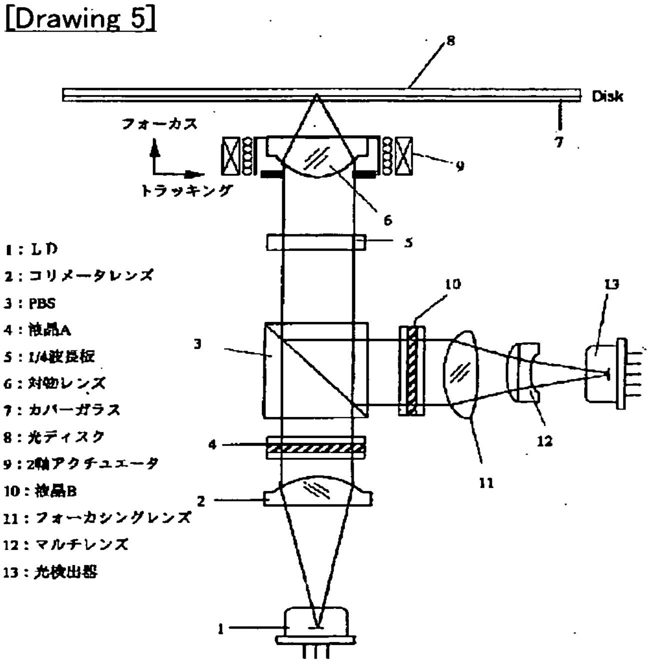
[Drawing 4]



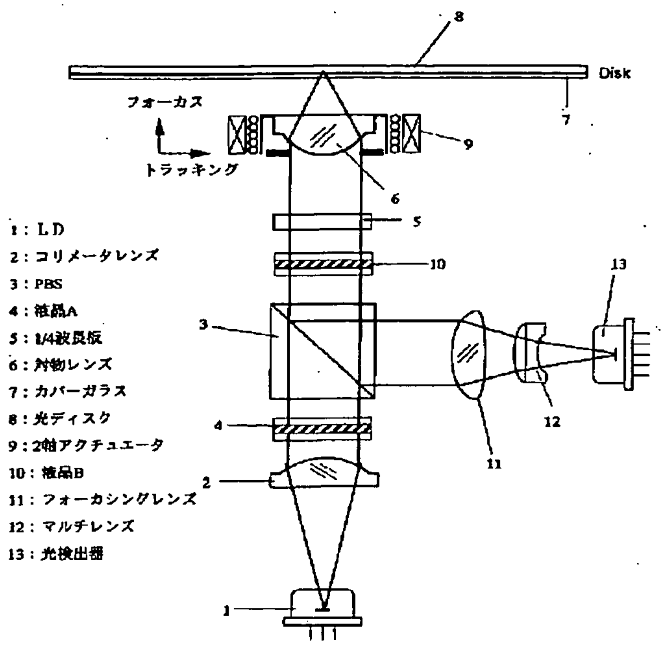
[Drawing 3]



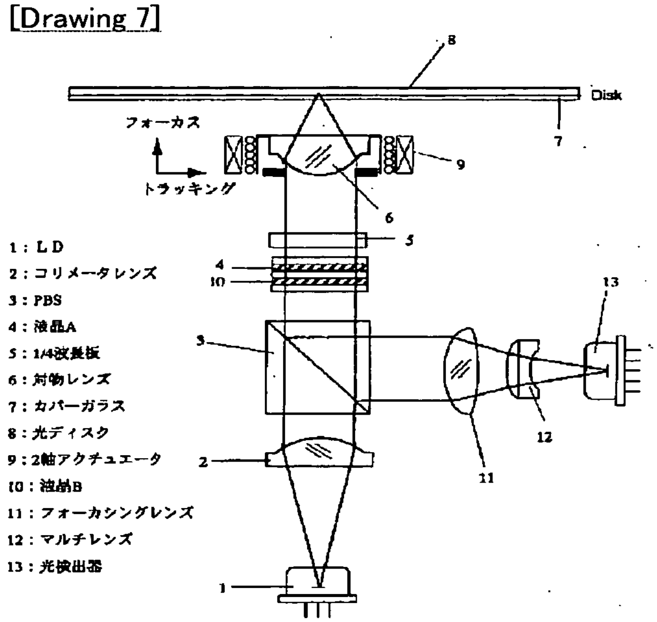
[Drawing 5]



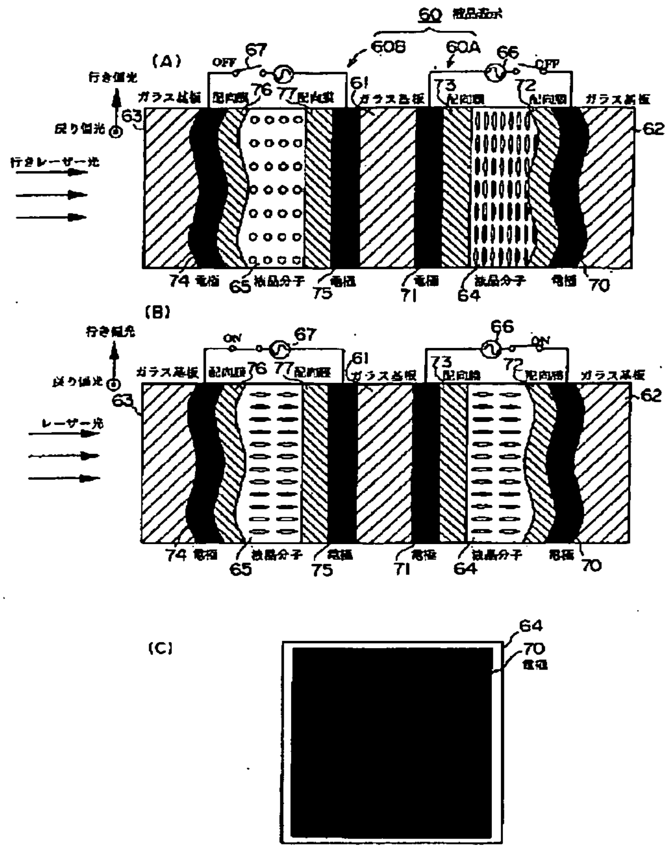
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]

(19)日本国特許庁（JP）　(12) 公開特許公報（A）　(11)特許出願公開番号
特開2002－251774
（P2002－251774A）
(43)公開日　平成14年9月6日(2002.9.6)

(51)Int.Cl.⁷	識別記号	F I		テーマコード*(参考)
G11B　7/135		G11B　7/135	Z	2H049
			A	2H088
G02B　5/30		G02B　5/30		5D119
G02F　1/13	505	G02F　1/13　505		

審査請求　未請求　請求項の数22　OL　（全 10 頁）

(21)出願番号　特願2001－46432(P2001－46432)
(22)出願日　平成13年2月22日(2001.2.22)

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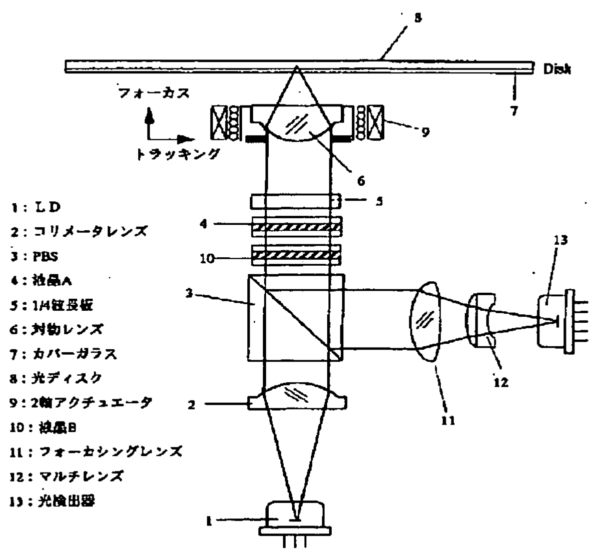
(54)【発明の名称】　光ピックアップ及びその波面収差補正装置

(57)【要約】
【課題】　光源から記録媒体を経て光検出器に到る光路上に配置される1／4波長板の影響を受けることなく、光学系に生じる波面収差を液晶素子によって適正に補正する。
【解決手段】　レーザー光源1から光ディスク3までの行き光路（第1の光路）の液晶素子A4を配置し、光ディスク3に入射する光の偏光方向に液晶を配向するようにして、行き光の収差を補正する。また、この液晶素子A4とは別にλ／4板5から光検出器13までの戻り光路（第2の光路）に液晶素子B10を追加配置し、戻り光の偏光方向に液晶を配向するようにして、戻り光の収差を補正する。これにより、行きと戻りで偏光状態が90度異なるので、収差は、それぞれ独立に補正される。



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【特許請求の範囲】

【請求項１】　光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップにおいて、

前記光源から光記録媒体に到る第１の光路に波面収差補正用の第１の液晶素子を設けるとともに、前記光記録媒体から光検出器に到る第２の光路に波面収差補正用の第２の液晶素子を設けた、

ことを特徴とする光ピックアップ。

【請求項２】　前記光源から出射された光を前記光記録媒体の情報記録面に集光させるための対物レンズと、前記光源と対物レンズとの間に配置された位相制御素子と、前記光源と位相制御素子との間に配置され、前記光源からの光を光記録媒体側に導くとともに、前記光記録媒体からの反射光を前記光検出器に導く光分岐素子とを有し、前記第１の液晶素子は前記光源と対物レンズとの間に配置され、前記第２の液晶素子は前記位相制御素子と光検出器との間に配置されていることを特徴とする請求項１記載の光ピックアップ。

【請求項３】　前記第１の液晶素子は前記光記録媒体に入射する光の偏光方向に液晶を配向するように配置し、前記第２の液晶素子は前記光検出器に入射する光の偏光方向に液晶を配向するように配置したことを特徴とする請求項２記載の光ピックアップ。

【請求項４】　前記第１の液晶素子及び第２の液晶素子は前記位相制御素子と光分岐素子の間に配置されていることを特徴とする請求項２記載の光ピックアップ。

【請求項５】　前記第１の液晶素子は前記位相制御素子と光分岐素子の間に配置され、前記第２の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項２記載の光ピックアップ。

【請求項６】　前記第１の液晶素子は前記光源と光分岐素子の間に配置され、前記第２の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項２記載の光ピックアップ。

【請求項７】　前記第１の液晶素子と第２の液晶素子が中間基板を共有して一体化された液晶素子よりなることを特徴とする請求項１記載の光ピックアップ。

【請求項８】　前記位相制御素子は１／４波長板であることを特徴とする請求項２記載の光ピックアップ。

【請求項９】　前記光分岐素子は偏光ビームスプリッタであることを特徴とする請求項２記載の光ピックアップ。

【請求項１０】　前記光記録媒体はディスク型媒体であることを特徴とする請求項１記載の光ピックアップ。

【請求項１１】　前記光源はレーザー光源であることを特徴とする請求項１記載の光ピックアップ。

【請求項１２】　光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップの波面収差補正装置において、

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前記光源から光記録媒体に到る第１の光路に配置される波面収差補正用の第１の液晶素子と、

前記光記録媒体から光検出器に到る第２の光路に配置される波面収差補正用の第２の液晶素子と、

を有することを特徴とする光ピックアップの波面収差補正装置。

【請求項１３】　前記光ピックアップは、前記光源から出射された光を前記光記録媒体の情報記録面に集光させるための対物レンズと、前記光源と対物レンズとの間に配置された位相制御素子と、前記光源と位相制御素子との間に配置され、前記光源からの光を光記録媒体側に導くとともに、前記光記録媒体からの反射光を前記光検出器に導く光分岐素子とを有し、前記第１の液晶素子は前記光源と対物レンズとの間に配置され、前記第２の液晶素子は前記位相制御素子と光検出器との間に配置されていることを特徴とする請求項１２記載の光ピックアップの波面収差補正装置。

【請求項１４】　前記第１の液晶素子は前記光記録媒体に入射する光の偏光方向に液晶を配向するように配置し、前記第２の液晶素子は前記光検出器に入射する光の偏光方向に液晶を配向するように配置したことを特徴とする請求項１３記載の光ピックアップの波面収差補正装置。

【請求項１５】　前記第１の液晶素子及び第２の液晶素子は前記位相制御素子と光分岐素子の間に配置されていることを特徴とする請求項１３記載の光ピックアップの波面収差補正装置。

【請求項１６】　前記第１の液晶素子は前記位相制御素子と前記光分岐素子の間に配置され、前記第２の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項１３記載の光ピックアップの波面収差補正装置。

【請求項１７】　前記第１の液晶素子は前記光源と光分岐素子の間に配置され、前記第２の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項１３記載の光ピックアップの波面収差補正装置。

【請求項１８】　前記第１の液晶素子と第２の液晶素子が中間基板を共有して一体化された液晶素子よりなることを特徴とする請求項１２記載の光ピックアップの波面収差補正装置。

【請求項１９】　前記位相制御素子は１／４波長板であることを特徴とする請求項１３記載の光ピックアップの波面収差補正装置。

【請求項２０】　前記光分岐素子は偏光ビームスプリッタであることを特徴とする請求項１３記載の光ピックアップの波面収差補正装置。

【請求項２１】　前記光記録媒体はディスク型媒体であ

ることを特徴とする請求項１２記載の光ピックアップの波面収差補正装置。

【請求項２２】　前記光源はレーザー光源であることを特徴とする請求項１２記載の光ピックアップの波面収差補正装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、光ディスクシステム、光磁気ディスクシステム、光カードシステムなどの各種光学式記録及び／または再生装置に用いられる光ピックアップ及びその波面収差補正装置に関する。

【０００２】

【従来の技術】近年、光ディスクを用いた各種の記録／再生装置においては、光ディスクの記録容量を高めるために、光ピックアップの光源としては短波長の半導体レーザー（ＬＤ）が利用され、また、対物レンズとしては開口率ＮＡの高いレンズが用いられている。すなわち、光ピックアップの光源に用いられるレーザーの波長は、例えばＣＤでは７８０ｎｍ、ＤＶＤでは６５０ｎｍというように、記録密度が高くなるに従って短くなっている。一方、対物レンズのＮＡは、例えばＣＤでは０．４５、ＤＶＤでは０．６０、というように、記録密度が高くなるに従って大きくなっている。また、最近では４０５ｎｍという青紫色のＬＤと、０．８５という高ＮＡ対物レンズが光ディスクの開発に用いられている。

【０００３】しかしながら、このようにＬＤの波長が短くなり、かつ、対物レンズのＮＡが大きくなると、種々の製造誤差に対して容易に波面収差が増大し、光学性能が劣化するという問題が生じる。そこで、この波面収差を補正する方法として、従来より様々な方法が考えられてきており、その１つに液晶素子を用いる方法がある。これはレーザーと対物レンズとの間に液晶素子を挿入し、透過光に所望の位相分布を与えるものである。すなわち、波面収差と逆の位相を対物レンズの入射光に予め与えることにより、結像面で無収差状態を得るものである。

【０００４】以下、液晶素子で透過光に位相分布を与える方法について説明する。まず、一般に液晶素子の液晶分子を封止する２つの基板には、通常はガラス製の平面基板が用いられており、これらガラス基板には、液晶に電圧を印加できるように電極が形成されている。そして、これらガラス基板内に封止される液晶分子は、各ガラス基板に形成された配向膜に沿って並んでおり、各ガラス基板の電極に電圧を印加することにより分子配列を変位させることができる。そして、この液晶分子の変位に伴い、配向膜に沿った方向の偏光成分に対しては屈折率が変わるので、透過光の位相を変えることが可能である。一方、配向膜と直交方向の偏光に対しては、電圧の印加にかかわらず、屈折率は一定なので位相変化は起こらない。

【０００５】次に、このような配向膜と平行な偏光の透過光に位相分布を与えるには、液晶に印加する電圧分布を作ればよい。そのための簡単な方法としては、電極を少なくとも２つ以上に分割された電極で形成し、これらの電極に所望の位相分布に従った電圧を別々に加える方法がある。このような方法により、電極数と印加電圧に見合った電圧分布を形成し、近似的に所望の位相分布を透過光に与えることが可能となる。この場合、もちろん分割数が細かいほど理想的な位相分布を発生できる。

【０００６】また、液晶に印加する電圧分布を与える他の方法として、各ガラス基板の液晶を挟み込む面の面形状を、液晶分子の厚みが収差の位相分布と相似形状となるように構成する方法がある。この場合、電極は分割することなく各基板面に対してベタに形成する。そして、電極には一様の電圧を印加する。この方法では、透過光の位相分布は透過する液晶分子の厚みと印加する電圧で決まる。そして、透過光に液晶素子がない場合の光学系が有する波面収差と逆の位相分布を与えれば、結像面では無収差となる。

【０００７】

【発明が解決しようとする課題】しかしながら、上述のような液晶素子を用いた波面収差補正手段においては、記録媒体から光検出器までの光路に発生する以下のような問題点がある。すなわち、例えば相変化型ディスクの記録／再生、あるいはＲＯＭディスクの再生などを行なう場合には、レーザーから１／４波長板（以下、λ／４板という）までの光路とλ／４板から光検出器までの光路とで偏光状態が直交していることになる。したがって、液晶素子を用いてレーザーから記録媒体までの光路の光学系の収差を補正しても、λ／４板から光検出器までの光路では、配向膜と偏光が直交しているために、記録媒体から光検出器までの光路の収差は補正されない。この状態で検出系で信号を検出すると、記録媒体から光検出器までの光路に大きな収差が残っている場合には、光検出器上でのスポットが拡大あるいは変形してしまい、正確な検出ができなくなり、良好な記録／再生が行なえないという問題が生じる。

【０００８】そこで本発明の目的は、光源から記録媒体を経て光検出器に到る光路上に配置される波長板の影響を受けることなく、光学系に生じる波面収差を液晶素子によって適正に補正することが可能な光ピックアップ及びその波面収差補正装置を提供することにある。

【０００９】

【課題を解決するための手段】本発明は前記目的を達成するため、光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップにおいて、前記光源から光記録媒体に到る第１の光路に波面収差補正用の第１の液晶素子を設けるとともに、前記光記録媒体から光検出器に到る第２の光

路に波面収差補正用の第２の液晶素子を設けたことを特徴とする。また本発明は、光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップの波面収差補正装置において、前記光源から光記録媒体に到る第１の光路に配置される波面収差補正用の第１の液晶素子と、前記光記録媒体から光検出器に到る第２の光路に配置される波面収差補正用の第２の液晶素子とを有することを特徴とする。

【００１０】本発明の光ピックアップでは、光源から光記録媒体に到る第１の光路に波面収差補正用の第１の液晶素子を設け、光記録媒体に入射する光の波面収差を補正する。また、光記録媒体から光検出器に到る第２の光路に波面収差補正用の第２の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正する。したがって、特に第２の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、ＲＦ信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【００１１】また本発明の波面収差補正装置でも同様に、光源から光記録媒体に到る第１の光路に波面収差補正用の第１の液晶素子を設け、光記録媒体に入射する光の波面収差を補正する。また、光記録媒体から光検出器に到る第２の光路に波面収差補正用の第２の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正する。したがって、特に第２の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、ＲＦ信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【００１２】

【発明の実施の形態】以下、本発明による光ピックアップ及びその波面収差補正装置の実施の形態について説明する。なお、以下に説明する実施の形態は、本発明の好適な具体例であり、技術的に好ましい種々の限定が付されているが、本発明の範囲は、以下の説明において、特に本発明を限定する旨の記載がない限り、これらの態様に限定されないものとする。

【００１３】本実施の形態では、上述した従来例におけるレーザー光源から記録媒体までの光路（第１の光路）の液晶素子とは別に、λ／４板から光検出器までの光路（第２の光路）に液晶素子を追加配置し、戻り光の偏光方向に液晶を配向するようにして戻りの収差を補正するようにしたものである。このような構成により、行きと戻りで偏光状態が９０度異なるので、収差は、それぞれ独立に補正される。この液晶素子を配置する場所は、戻りの光路であればどこでもよく、行きと戻りが重なっている場所であってもよい。

【００１４】この結果、記録媒体から光検出器までの光路においても、波面収差を良好に補正することができる。したがって、光検出器上でのスポットが拡大あるいは変形することなく、記録／再生を良好に行うことが可能となる。なお、一般にレーザーからλ／４板までの第１の光路で発生する収差と、記録媒体から光検出器までの第２の光路で発生する収差とは互いに等しいので、レーザーからλ／４板までの第１の光路の収差を補正する液晶素子と、記録媒体から光検出器までの第２の光路の収差を補正する液晶素子の補正量は同じでよい。すなわち、２枚の液晶素子は配向が直交しているだけで、制御する量や分布は同じものとなる。

【００１５】以下、本実施の形態における具体的な実施例について図面を用いて詳細に説明する。

（第１実施例）図１は、本発明の第１実施例による光ピックアップの光学系の構成を示す概略説明図である。光ディスク８は、相変化型ディスクあるいは金属膜のＲＯＭディスクであり、カバーガラス７を透過して信号記録面にレーザー光が照射され、信号記録面に記録されたピットパターンが光ピックアップによって読み出される。光ピックアップは、対物レンズ６を搭載した２軸アクチュエータ９を有し、この２軸アクチュエータ９の駆動制御によって対物レンズ６をフォーカス方向及びトラッキング方向に移動し、光ディスク８へのアクセスを行なう。

【００１６】レーザー光源（ＬＤ）１と対物レンズ６との間の光路には、コリメータレンズ２、偏光ビームスプリッタ（光分岐素子）３、液晶素子Ａ４、液晶素子Ｂ１０、及び１／４波長板（位相制御素子）５が設けられている。また、偏光ビームスプリッタ３と光検出器１３との光路には、フォーカシングレンズ１１、及びマルチレンズ１２が設けられている。このうち、液晶素子Ａ４及び液晶素子Ｂ１０が、本形態における波面収差補正装置を構成するものであり、液晶素子Ａ４はＬＤ１から光ディスク８に入射するレーザー光の波面収差を補正するものであり、液晶素子Ｂ１０は光ディスク８で反射した戻りレーザー光の波面収差を補正するものである。なお、その他は、従来と同様の構成であるので詳細は省略する。

【００１７】次に、このような本形態の光ピックアップにおける波面収差補正装置の構成及び動作について説明する。図２は、本例で用いる液晶素子Ａ４、Ｂ１０の構造を示す説明図である。本例で用いる液晶素子Ａ４、Ｂ１０は、互いに共通の構造を有する液晶素子２０の角度を変えて配置したものであり、図２（Ａ）は液晶素子２０の電源オフ時の状態を示し、図２（Ｂ）は液晶素子２０の電源オン時の状態を示している。また、図２（Ｃ）は液晶素子２０の電極の正面構造を示している。図示のように、本例の液晶素子２０は、一対のガラス基板２

１、２２によって液晶分子２３を封止したものである。各ガラス基板２１、２２の対向面には、電源２６によって液晶に電圧を印加するための電極膜２４、２５が設けられており、さらに各電極膜２４、２５の内側に配向膜２７、２８が形成されている。また、各電極膜２４、２５は、図２（Ｃ）に示すように、同心円状に分割されており、各分割電極膜に異なるレベルの電圧を印加することにより、液晶に印加する電圧分布を得るようになっている。

【００１８】このような液晶素子２０は、図２（Ａ）に示すように、電源２６のオフ時において、配向膜２７、２８に沿った液晶分子の配列を有している。そして、電源２６をオンすると、図２（Ｂ）に示すように、各基板２１、２２の面方向に沿って寝ていた液晶分子が立ち上がり、屈折率が変わるので、透過光に位相分布を与えることが可能である。本例では、このような液晶素子２０を液晶素子Ａ４、Ｂ１０に用いることにより、光ディスク８に入射する往路（行き）のレーザー光の直線偏光に対しては液晶素子Ａ４によって位相分布を変位させ、光ディスク８から反射して光検出器１３に入射する復路（戻り）のレーザー光の直線偏光に対しては液晶素子Ｂ１０によって位相分布を変位させるものである。

【００１９】なお、図２に示す液晶素子２０では、分割電極によって液晶に印加する電圧分布を得るようにしたが、この代わりに図３に示すように、基板形状を変形し、液晶分子の厚みが収差の位相分布と相似形状となるように構成した液晶素子３０を用いてもよい。すなわち、図３に示す例では、液晶素子３０の一方のガラス基板３１の内側面がそれぞれ図示のような曲線形状を有しており、これらガラス基板３１の内側面に配向膜３７及び電極膜３４がベタ形成されている。また、図３（Ｃ）に示すように、液晶素子３０の電極膜３４、３５は、それぞれ分割されておらず、電源３６によって全体に共通の電圧が印加される。なお、他方のガラス基板３２や液晶分子３３、電極膜３５等は上述した図２に示す例と共通であるものである。このような液晶素子３０を用いた液晶素子Ａ４、Ｂ１０においても、上述した液晶素子Ａ４、Ｂ１０と同様の作用を得ることができる。

【００２０】次に、以上のような構成の波面収差補正装置の動作について説明する。まず、偏光ビームスプリッタプリズム（ＰＢＳ）３から光ディスク８へ向かう直線偏光は、その偏光方向に配向膜２７、２８をもつ第1の液晶素子Ａ４によって所望の位相分布が与えられる。すなわち、液晶素子Ａ４において、各電極膜２４、２５に電圧を加えると各基板２１、２２の表面に寝ていた液晶分子が立ち上がり、屈折率が変わるので、透過光に位相分布を与えることが可能である。一方、第２の液晶素子Ｂ１０は、配向膜を偏光方向と直交させているので、ＬＤ１から光ディスク８までの光路では透過光に影響を与えない。液晶素子Ａ４を透過した光は、λ／４板５で円偏光となり、対物レンズ６により、光ディスク８の信号面で集光される。ここで、往路（行き）の光学系の収差は、液晶素子Ａ４で与えられた位相分布で補正されており、光ディスク８の信号記録面で回折限界のスポットが得られる。

【００２１】次に、光ディスク８で反射された光は、再びλ／４板５を通って往路と直交する直線偏光となる。この直線偏光は、その偏光方向に配向膜２７、２８をもつ液晶素子Ｂ１０によって所望の位相分布を与えられる。一方、液晶素子Ａ４では、配向膜２７、２８を偏光方向と直交させているので、λ／４板５から光検出器１３までの光路では透過光に影響を与えない。これにより、光ディスク８の信号記録面から戻ってきた光の収差を補正する。液晶素子Ｂ１０を透過した光は、ＰＢＳ３で反射されて光検出器１３へ向かい、この光検出器１３の出力からフォーカス誤差信号、トラッキング誤差信号、ＲＦ信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器１３上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では、戻り光の収差が液晶素子Ｂ１０により補正されているので、良好な検出が可能となる。なお、液晶素子Ａ４と液晶素子Ｂ１０の位置関係は、図１に示す配置と逆であっても同じ効果が得られる。

【００２２】（第２実施例）図４は、本発明の第２実施例による光ピックアップの光学系の構成を示す概略説明図である。この第２実施例は、上述した２つの液晶素子Ａ４、Ｂ１０の配置を変えたものであり、その他は上記第１実施例と同様であるので、共通の構成について同一符号を用いて説明する。本実施例では、第１の液晶素子Ａ４については第１実施例と同様にＰＢＳ３とλ／４板５との間に配置しているが、第２の液晶素子Ｂ１０はＰＢＳ３とフォーカシングレンズ１１との間に配置したものである。なお、本実施例においても、液晶素子Ａ４、Ｂ１０自体の構成も第１実施例と同様であり、例えば図２または図３に示すものを用いるものとする。

【００２３】次に、以上のような構成の波面収差補正装置の動作について説明する。ＰＢＳ３から光ディスク８へ向かう直線偏光は、その偏光方向に配向膜２７、２８をもつ液晶素子Ａ４によって所望の位相分布を与えられる。液晶素子Ａ４を透過した光は、λ／４板５で円偏光となり、対物レンズ６により光ディスク８の信号記録面で集光される。往路（行き）の光学系の収差は液晶素子Ａ４で与えられた位相分布で補正されており、光ディスク８の信号記録面で回折限界のスポットが得られる。そして、光ディスク８で反射された光は、再びλ／４板５を通って往路（行き）と直交する直線偏光となる。この直線偏光は、ＰＢＳ３で反射され、その偏光方向に配向膜をもつ液晶素子Ｂ１０によって所望の位相分布を与えられる。これにより、光ディスク８の信号記録面から戻ってきた光の収差を補正する。液晶素子Ｂ１０を透過し

た光は、光検出器１３へ向かい、フォーカス誤差信号、トラッキング誤差信号、ＲＦ信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器１３上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では戻り光の収差が液晶素子Ｂ１０により補正されているので、良好な検出が可能となる。

【００２４】（第３実施例）図５は、本発明の第３実施例による光ピックアップの光学系の構成を示す概略説明図である。この第３実施例も、上述した２つの液晶素子Ａ４、Ｂ１０の配置を変えたものであり、その他は上記第１実施例と同様であるので、共通の構成について同一符号を用いて説明する。本実施例は、第１の液晶素子Ａ４はコリメータレンズ２とＰＢＳ３との間に配置し、第２の液晶素子Ｂ１０は第２実施例と同様にＰＢＳ３とフォーカシングレンズ１１との間に配置したものである。なお、本実施例においても、液晶素子Ａ４、Ｂ１０自体の構成も第１実施例と同様であり、例えば図２または図３に示すものを用いるものとする。

【００２５】次に、以上のような構成の波面収差補正装置の動作について説明する。ＬＤ１からＰＢＳ３へ向かう直線偏光は、その偏光方向に配向膜２７、２８をもつ液晶素子Ａ４によって所望の位相分布を与えられる。液晶素子Ａ４を透過した光は、ＰＢＳ３を透過してλ／４板５で円偏光となり、対物レンズ６によって光ディスク８の信号記録面で集光される。往路（行き）の光学系の収差は、液晶素子Ａ４で与えられた位相分布で補正されており、光ディスク８の信号回折限界のスポットが得られる。また、光ディスク８で反射された光は、再びλ／４板５を通って往路（行き）と直交する直線偏光となる。この直線偏光は、ＰＢＳ３で反射され、その偏光方向に配向膜２７、２８をもつ液晶素子Ｂ１０によって所望の位相分布を与えられる。これにより、光ディスク８の信号記録面から戻ってきた光の収差を補正する。そして、この液晶素子Ｂ１０を透過した光は、光検出器１３へ向かい、フォーカス信号誤差、トラッキング誤差信号、ＲＦ信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器１３上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では、液晶素子Ｂ１０により、戻り光の収差が補正されているので、良好な検出が可能となる。

【００２６】（第４実施例）図６は、本発明の第４実施例による光ピックアップの光学系の構成を示す概略説明図である。この第４実施例も、上述した２つの液晶素子Ａ４、Ｂ１０の配置を変えたものであり、その他は上記第１実施例と同様であるので、共通の構成について同一符号を用いて説明する。本実施例は、第１の液晶素子Ａ４は第３実施例と同様にコリメータレンズ２とＰＢＳ３との間に配置し、第２の液晶素子Ｂ１０は第１実施例と同様にＰＢＳ３とλ／４板５との間に配置したものである。なお、本実施例においても、液晶素子Ａ４、Ｂ１０自体の構成も第１実施例と同様であり、例えば図２または図３に示すものを用いるものとする。

【００２７】次に、以上のような構成の波面収差補正装置の動作について説明する。ＬＤ１からＰＢＳ３へ向かう直線偏光は、その偏光方向に配向膜をもつ液晶素子Ａ４によって所望の位相分布を与えられる。そして、この液晶素子Ａ４を透過した光は、ＰＢＳ３を透過し、液晶素子Ｂ１０に入射する。この液晶素子Ｂ１０は、配向膜を偏光方向と直交させているので、透過光に影響を与えない。次に、液晶素子Ａ４を透過した光は、λ／４板５で円偏光となり、対物レンズ６により光ディスク８の信号記録面で集光される。このような往路（行き）の光学系の収差は、液晶素子Ａ４で与えられた位相分布で補正されており、光ディスク８の信号記録面で回折限界のスポットが得られる。

【００２８】次に、光ディスク８で反射された光は、再びλ／４板５を通って往路（行き）と直交する直線偏光となる。この直線偏光は、その偏光方向に配向膜をもつ液晶素子Ｂ１０によって所望の位相分布を与えられる。これにより、光ディスク８の信号記録面から戻ってきた光の収差を補正する。そして、この液晶素子Ｂ１０を透過した光は、ＰＢＳ３で反射されて光検出器１３へ向かい、フォーカス誤差信号、トラッキング誤差信号、ＲＦ信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器１３上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では、戻り光の収差が液晶素子Ｂ１０により補正されているので、良好な検出が可能となる。

【００２９】（第５実施例）図７は、本発明の第５実施例による光ピックアップの光学系の構成を示す概略説明図である。この第５実施例は、上述した２つの液晶素子Ａ４、Ｂ１０の代わりに、これら２つの液晶素子を一体化した液晶素子６０をＰＢＳ３とλ／４板５との間に配置した例であり、その他は上記第１実施例と同様であるので、共通の構成について同一符号を用いて説明する。図８は、液晶素子６０の構造を示す断面図であり、図８（Ａ）は電源オフ時の状態を示し、図８（Ｂ）は電源オン時の状態を示している。また、図８（Ｃ）は液晶素子６０の電極の正面構造を示している。

【００３０】この液晶素子６０は、平板状の中間ガラス基板６１によって２つの液晶素子６０Ａ、６０Ｂを一体化したものであり、両側のガラス基板６２、６３を図３に示した液晶素子３０と同様に、それぞれの内側面で図示のような曲線状に形成し、各液晶分子６４、６５の厚みが収差の位相分布と相似形状となるように構成したものである。液晶素子６０Ａでは、外側のガラス基板６２の内側面に電極膜７０及び配向膜７２がベタで形成され、中間ガラス基板６１の内側面に電極膜７１及び配向膜７３が平面状に形成され、その間に液晶分子６４が封

止されている。この液晶素子６０Ａの液晶分子６４の配向は、図８（Ａ）に示すように、電源オフ時には、基板面に沿って、戻り偏光の方向に配置されている。

【００３１】一方、液晶素子６０Ｂでは、外側のガラス基板６３の内側面に電極膜７４及び配向膜７６がベタで形成され、中間ガラス基板６１の内側面に電極膜７５及び配向膜７７が平面状に形成され、その間に液晶分子６５が封止されている。この液晶素子６０Ｂの液晶分子６５の配向は、図８（Ａ）に示すように、電源オフ時には、基板面に沿って、行き偏光の方向に配置されている。そして、このような液晶素子６０では、各液晶素子６０Ａ、６０Ｂの電源６６、６７をオンすると、図８（Ｂ）に示すように、各液晶分子６４、６５は光の透過方向に沿って配置される。なお、このような液晶素子６０における液晶素子６０Ａと液晶素子６０Ｂの位置関係は逆であっても同じ効果が得られる。

【００３２】次に、以上のような構成の波面収差補正装置の動作について説明する。ＰＢＳ３から光ディスク８へ向かう直線偏光は液晶素子６０を透過する。この液晶素子６０を構成する２つの液晶素子６０Ａ、６０Ｂは、それぞれの液晶分子の配向が互いに直交しており、往路（行き）の光は、その偏光方向に配向膜をもつ液晶素子６０Ａ（液晶素子Ａ４）によって所望の位相分布を与えられる。また、これと９０度の配向を有する液晶素子６０Ｂ（液晶素子Ｂ１０）は光の位相分布に影響を与えない。そして、この液晶素子６０を透過した光は、λ／４板５で円偏光となり、対物レンズ６により光ディスク８の信号記録面で集光される。往路（行き）の光学系の収差は液晶素子６０Ａで与えられた位相分布で補正されており、光ディスク８の信号記録面で回折限界のスポットが得られる。

【００３３】次に、光ディスク８で反射された光は、再びλ／４板５を通って往路（行き）と直交する直線偏光となる。この直線偏光は、その偏光方向に配向膜をもつ液晶素子６０Ｂによって所望の位相分布を与えられる。これにより光ディスク８の信号記録面から戻ってきた光の収差を補正する。また、これと９０度の配向を有する液晶素子６０Ａは、光の位相分布に影響を与えない。液晶素子６０を透過した光は、ＰＢＳ３で反射されて光検出器１３へ向かい、フォーカス誤差信号、トラッキング誤差信号、ＲＦ信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器１３上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では戻り光の収差が液晶素子６０Ｂにより補正されているので、良好な検出が可能となる。

【００３４】なお、以上の各実施例では、行きと戻りの収差補正を行う２つの液晶素子Ａ、Ｂを対物レンズ６と一体で駆動することが可能であり、これが望ましいものである。すなわち、対物レンズ６がトラッキング方向に駆動すると、液晶の中心と偏芯し、収差が発生する恐れがある。そこで、これを一体駆動によって防止することが可能である。また、以上の各実施例では、光記録媒体を光ディスクとした例について説明したが、本発明はこれに限らず、例えば光カードや光磁気ディスク等のシステムについても同様に適用可能である。また、本発明において光ピックアップとは、光源や光検出器を光ヘッドブロック内に搭載して一体に移動するものに限らず、光源や光検出器を光ヘッドブロックとは別に固定的に配置した構造のものをも含むものとする。

【００３５】

【発明の効果】以上説明したように本発明の光ピックアップによれば、光源から光記録媒体に到る第１の光路に波面収差補正用の第１の液晶素子を設け、光記録媒体に入射する光の波面収差を補正するとともに、光記録媒体から光検出器に到る第２の光路に波面収差補正用の第２の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正することができる。したがって、特に第２の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、ＲＦ信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【００３６】また本発明の波面収差補正装置によれば、光源から光記録媒体に到る第１の光路に波面収差補正用の第１の液晶素子を設け、光記録媒体に入射する光の波面収差を補正するとともに、光記録媒体から光検出器に到る第２の光路に波面収差補正用の第２の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正することができる。したがって、特に第２の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、ＲＦ信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【図面の簡単な説明】

【図１】本発明の第１実施例における光ピックアップの光学系の構成例を示す説明図である。

【図２】図１に示す光ピックアップに設けられる液晶素子の第１の例を示す説明図である。

【図３】図１に示す光ピックアップに設けられる液晶素子の第２の例を示す説明図である。

【図４】本発明の第２実施例による光ピックアップの光学系の構成例を示す説明図である。

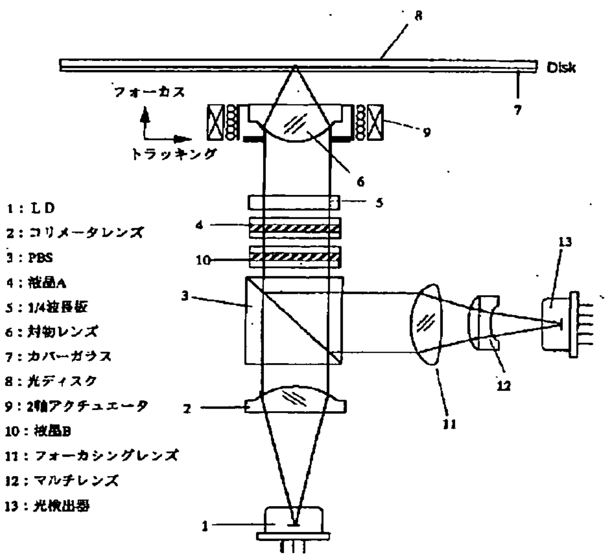
【図５】本発明の第３実施例による光ピックアップの光学系の構成例を示す説明図である。

【図６】本発明の第４実施例による光ピックアップの光学系の構成例を示す説明図である。

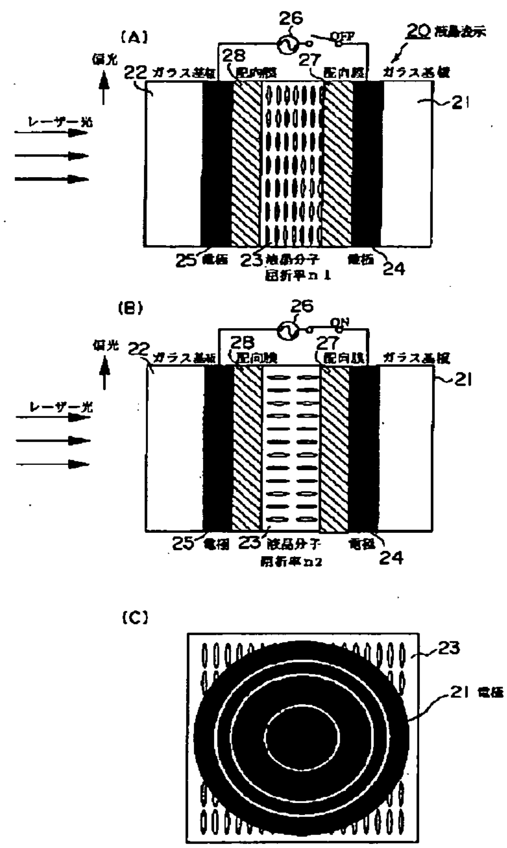
【図７】本発明の第５実施例による光ピックアップの光

学系の構成例を示す説明図である。
【図８】図７に示す光ピックアップに設けられる液晶素子の例を示す説明図である。
【符号の説明】
１……レーザー光源（ＬＤ）、２……コリメータレンズ、３……偏光ビームスプリッタ（ＰＢＳ）、４……液晶素子Ａ、５……１／４波長板、６……対物レンズ、７……カバーガラス、８……光ディスク、９……２軸アクチュエータ、１０……液晶素子Ｂ、１１……フォーカシングレンズ、１２……マルチレンズ、１３……光検出器。

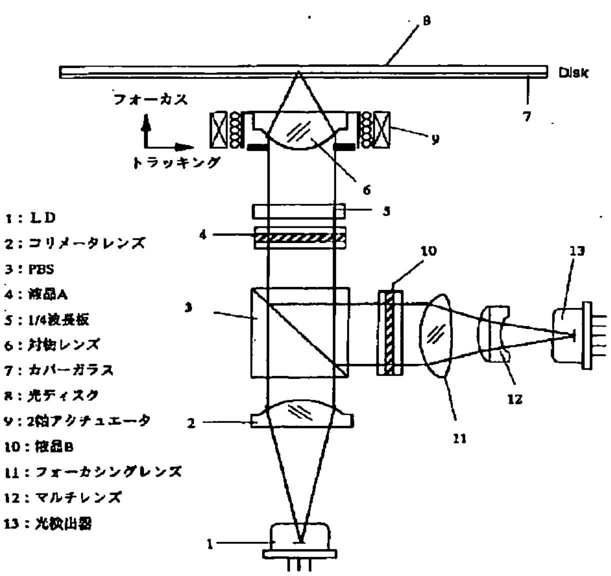
【図１】



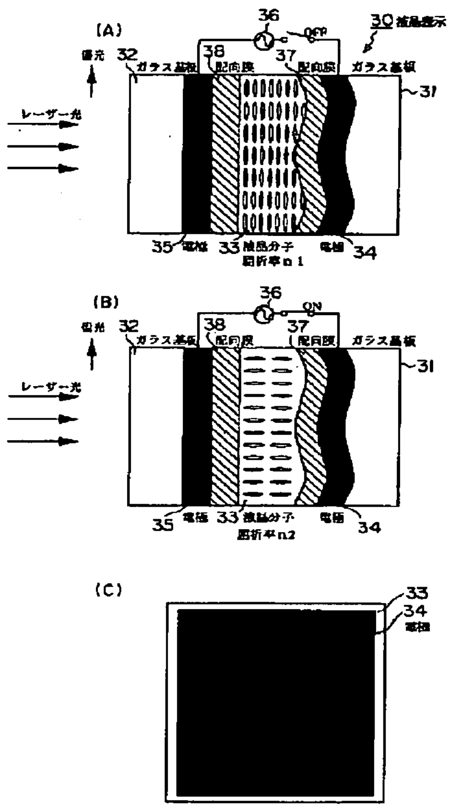
【図２】



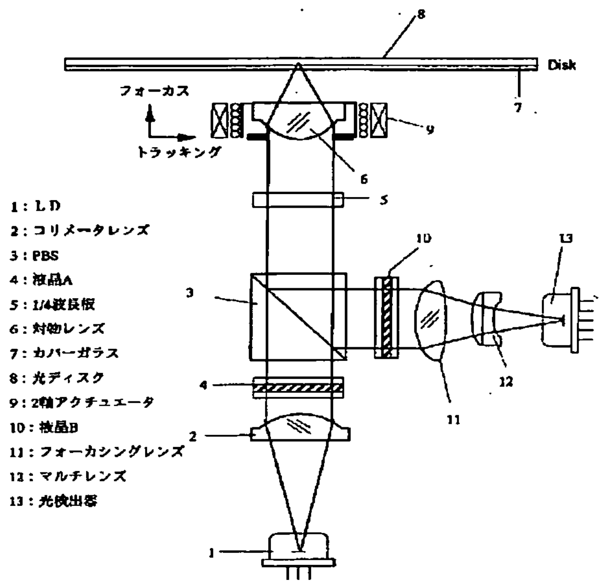
【図４】



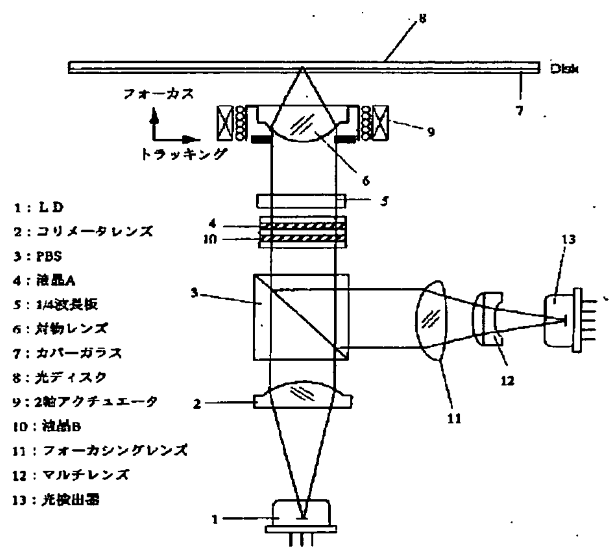
【図３】


(A)
36
OFF
30 液晶表示
偏光
32
ガラス基板
38
配向膜
37
配向膜
ガラス基板
31
レーザー光
35 電極
33 液晶分子
屈折率n１
電極
34
(B)
36
ON
偏光
32
ガラス基板
38
配向膜
37
配向膜
ガラス基板
31
レーザー光
35 電極
33 液晶分子
屈折率n2
電極
34
(C)
33
34
電極

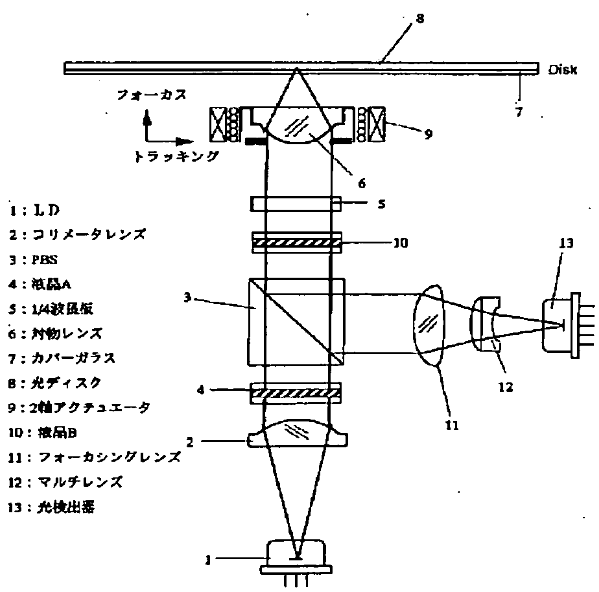
【図５】


8
Disk
7
フォーカス
トラッキング
9
6
5
10
13
3
4
12
11
2
1
1：LD
2：コリメータレンズ
3：PBS
4：液晶A
5：1/4波長板
6：対物レンズ
7：カバーガラス
8：光ディスク
9：2軸アクチュエータ
10：液晶B
11：フォーカシングレンズ
12：マルチレンズ
13：光検出器

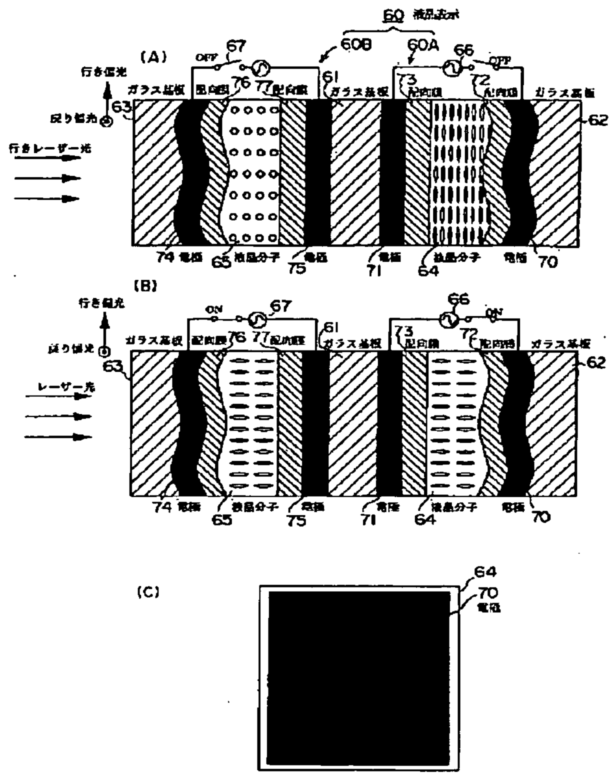
【図７】


8
Disk
7
フォーカス
トラッキング
9
6
5
4
10
13
3
2
12
11
1
1：LD
2：コリメータレンズ
3：PBS
4：液晶A
5：1/4波長板
6：対物レンズ
7：カバーガラス
8：光ディスク
9：2軸アクチュエータ
10：液晶B
11：フォーカシングレンズ
12：マルチレンズ
13：光検出器

【図６】


8
Disk
7
フォーカス
トラッキング
9
6
5
10
13
3
4
2
12
11
1
1：LD
2：コリメータレンズ
3：PBS
4：液晶A
5：1/4波長板
6：対物レンズ
7：カバーガラス
8：光ディスク
9：2軸アクチュエータ
10：液晶B
11：フォーカシングレンズ
12：マルチレンズ
13：光検出器

【図８】



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Ｆターム(参考)　2H049 BA05 BA06 BA42 BA46 BB03
BC21
2H088 EA47 EA62 HA17 HA20
5D119 AA09 AA21 BA01 BA02 BB01
BB04 BB05 EC01 FA02 JA09
JA12 JA32 LB05